In the Claims

Applicant has submitted a new complete claim set showing amended claims with insertions indicated by underlining and deletions indicated by strikeouts and/or double bracketing.

Please amend pending claim 6 as noted below.

Please add new claims 7-54 as shown below.

1. (Previously presented) A digital subscriber line transmission system using QAM modulation on N=2048 or 4096 tones spaced by 4.3125 kHz, including at least two operating modes:

a VDSL standard operating mode where all N tones are used to convey significant values; and

an ADSL standard operating mode where only the first n=128 or 256 among the N tones are used to convey significant values.

2. (Previously presented) The system of claim 1, comprising, on the transmitter side:

an inverse fast Fourier transform circuit having N frequency domain value inputs corresponding to said tones, among which only the first receive values corresponding to the n used tones, the remaining inputs being zeroed,

a decimator providing one sample for every r samples output by the inverse fast Fourier transform circuit, with r = N/n, and

a digital-to-analog converter coupled between the decimator and a subscriber line.

3. (Previously presented) The system of claim 2, comprising, on the receiver side:

an analog-to-digital converter sampling the signal on the subscriber line at a frequency F/r, where F is the operating frequency of the inverse fast Fourier transform circuit;

an interpolator generating samples at frequency F from the samples provided by the analog-to-digital converter; and

a fast Fourier transform circuit operating at frequency F and receiving the samples from the interpolator through a time domain equalizer;

wherein, when all N tones are used, the time domain equalizer is bypassed.

4. (Previously presented) The system of claim 1 comprising, at a transmitter side, an inverse fast Fourier transform circuit having:

a number of frequency domain inputs selectable at least among values N and n; and

an operating frequency selectable at least among two values F and fn proportional, respectively, to the frequency of the last of the N tones and the last of the n tones.

5. (Previously presented) The system of claim 4, comprising, at a receiver side, a fast Fourier transform circuit having:

a number of frequency domain outputs selectable at least among values N and n; and

an operating frequency selectable at least among values F and fn.

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6. (Currently amended) The system of claim 5, wherein each of the inverse fast Fourier transform and fast Fourier transform circuits includes five radix-4 stages and a last stage having a radix selectable among 2 and 4, all connected to operate in pipeline mode, the desired number of frequency domain inputs or outputs of the circuit being selectable by bypassing a [an appropriate] number of the five radix-4 stages and by selecting the radix of the last stage.

7. (New) The system of claim 6, wherein the desired number of frequency domain inputs or outputs of the circuit is the product of the radices of all stages which are not bypassed.

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8. (New) The system of claim 6:

wherein each stage receives and provides complex coefficients at a digital data transmission rate;

wherein each complex coefficient has a real part and an imaginary part;

wherein the real part of each complex coefficient and the imaginary part of each complex coefficient are processed in two distinct cycles; and

wherein the operating frequency of the system is twice the digital data transmission rate.

9. (New) The system of claim 6, wherein an ADSL-Lite standard operating mode is implemented by bypassing two of the five radix-4 stages and selecting the last stage to be radix-2.

10. (New) The system of claim 9, wherein the operating frequency is 1.104 MHz.

11. (New) The system of claim 6, wherein an ADSL standard operating mode is implemented by bypassing two of the five radix-4 stages and selecting the last stage to be radix-4.

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12. (New) The system of claim 11, wherein the operating frequency is 2.208 MHz.

13. (New) The system of claim 6, wherein a VDSL standard operating mode, using N= 2048 tones, is implemented by bypassing none of the five radix-4 stages and selecting the last stage to be radix-2.

CONT

14. (New) The system of claim 13, wherein the operating frequency is 17.664 MHz.

15. (New) The system of claim 6, wherein a VDSL standard operating mode, using N=4096 tones, is implemented by bypassing none of the five radix-4 stages and selecting the last stage to be radix-4.

16. (New) The system of claim 15, wherein the operating frequency is 35.328 MHz.

17. (New) The system of claim 6, wherein a VDSL standard operating mode being used for a VDSL-TDD transmission using 512 tones is implemented by bypassing one of the radix-4 stages and selecting the last stage to be radix-2.

18. (New) The system of claim 6, wherein a VDSL standard operating mode being used for a VDSL-TDD transmission using 256 tones is implemented by bypassing two of the radix-4 stages and selecting the last stage to be radix-4.

19. (New) The system of claim 6, wherein a VDSL standard operating mode may be used for a VDSL-TDD transmission, the VDSL-TDD transmission having a maximum frequency of 17.664 MHz.

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20. (New) The system of claim 6, wherein a VDSL standard operating mode may be used for a VDSL-TDD transmission, the VDSL-TDD transmission having a maximum frequency of 35.328 MHz.

21. (New) The system of claim 1, wherein a receiving modem can identify the standard operating mode before establishing communication with a transmitting modem.

22. (New) The system of claim 21,

CONT

wherein the transmitting modem sends a modem identification signature; and

wherein the receiving modem, by identifying which of the N tones are present in the modem identification signature, identifies the standard operating mode.

23. (New) The system of claim 22, wherein the modem identification signature comprises a signal comprising a plurality of the N tones.

24. (New) The system of claim 23, wherein the modem identification signature of an ADSL modem comprises a plurality of consecutive tones.

25. (New) The system of claim 23,

wherein the transmitting modem is an ADSL modem; and

wherein the modem identification signature comprises every pth tone of the N tones, p being a power of 2.

26. (New) The system of claim 23, wherein the transmitting modem is a VDSL Zipper modem and the receiving modem is a VDSL-TDD modem; and

wherein the modem identification signature comprises every 8th tone of the VDSL Zipper modem.

27. (New) The system of claim 23, wherein the transmitting modem is a VDSL Zipper modem and the receiving modem is a VDSL-TDD modem; and

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wherein the modem identification signature comprises every 4th tone of the VDSL Zipper modem.

28. (New) A method for operating a digital subscriber line transmission system, the system using N tones which correspond to N frequency domain value inputs, and having a maximum frequency, the method comprising:

operating the system in a first operating mode, using q tones of the N possible tones as frequency domain value inputs;

CONT

zeroing the N-q remaining frequency domain value inputs of the N frequency domain value inputs not included in the q frequency domain value inputs;

setting the operating frequency of the system to q/N of the maximum operating frequency;

operating the system in a second operating mode, the second operating mode using all N frequency domain value inputs; and

setting the operating frequency of the system to the maximum operating frequency.

29. (New) The method of claim 28, wherein operating the system in a first operating mode further comprises selecting the q tones to be used as frequency domain value inputs by bypassing elements of a pipelined circuit.

30. (New) The method of claim 29,

wherein the first operating mode is ADSL standard operating mode;

wherein the pipelined circuit comprises five pipelined radix-4 stages and a last stage operable as radix-2 or radix-4; and

wherein operating the system in the first operating mode further comprises bypassing two of the five pipelined radix-4 stages and operating the last stage as radix-4.

31. (New) The method of claim 30, wherein setting the operating frequency to q/N of the maximum operating frequency further comprises setting the operating frequency of the system to 2.208 MHz.

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32. (New) The method of claim 29,

wherein the first operating mode is ADSL-Lite;

wherein the pipelined circuit comprises five pipelined radix-4 stages and a last stage operable as radix-2 or radix-4; and

wherein operating the system in the first operating mode further comprises bypassing two of the five pipelined radix-4 stages and operating the last stage as radix-2.

CONT

33. (New) The method of claim 32, wherein setting the operating frequency to q/N of the maximum operating frequency further comprises setting the operating frequency of the system to 1.104 MHz.

34. (New) The method of claim 29,

wherein the second operating mode is a VDSL using N=2048 tones;

wherein the pipelined circuit comprises five pipelined radix-4 stages and a last stage operable as radix-2 or radix-4; and

wherein operating the system in the second operating mode further comprises not bypassing any of the five pipelined radix-4 stages and operating the last stage as radix-2.

35. (New) The method of claim 34, wherein setting the operating frequency of the system to the maximum operating frequency further comprises setting the operating frequency to 17.664 MHz.

36. (New) The method of claim 29,

wherein the second operating mode is a VDSL standard with N=4096 tones;

wherein the pipelined circuit comprises five pipelined radix-4 stages and a last stage operable as radix-2 or radix-4; and

wherein operating the system in the second operating mode further comprises not bypassing any of the five pipelined radix-4 stages and operating the last stage as radix-4.

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37. (New) The method of claim 36, wherein setting the operating frequency of the system to the maximum operating frequency further comprises setting the operating frequency to 35.328 MHz.

38. (New) The method of claim 29,

wherein the first operating mode is VDSL-TDD with q=512 frequency domain inputs;

wherein the pipelined circuit comprises five pipelined radix-4 stages and a last stage operable as radix-2 or radix-4; and

CONT

wherein operating the system in the first operating mode further comprises bypassing one of the five pipelined radix-4 stages and operating the last stage as radix-2.

39. (New) The method of claim 29,

wherein the first operating mode is a VDSL-TDD standard using q=256 frequency domain inputs;

wherein the pipelined circuit comprises five pipelined radix-4 stages and a last stage operable as radix-2 or radix-4; and

wherein operating the system in the first operating mode further comprises bypassing two of the five pipelined radix-4 stages and operating the last stage as radix-4.

40. (New) A method by which a receiving modem can identify an operating mode of a plurality of operating modes of a transmitting modem using N tones, wherein the transmitting

modem and the receiving modem are capable of functioning in any of the a plurality of operating modes, the method comprising:

tuning the receiving modem to the transmitting modem prior to the receiving modem establishing a communication with the transmitting modem;

using the transmitting modem to send a modem identification signal to the receiving modem; and

the receiving modem obtaining the modem identification signal and identifying the operating mode.

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41. (New) The method according to claim 40, wherein tuning the receiving modem to the transmitting modem prior to the receiving modem establishing communication with the transmitting modem further comprises the receiving modem using at least the N tones used by the transmitting modem.

42. (New) The method according to claim 41, wherein using the transmitting modem to send a modem identification signal to the receiving modem further comprises the transmitting modem sending a specific set of tones chosen from the set of N possible tones.

CONT

43. (New) The method according to claim 42, wherein using the transmitting modem to send a modem identification signal to the receiving modem further comprises using a VDSL Zipper modem to send every 8^{th} tone of the set of N possible tones to a VDSL-TDD modem.

44. (New) The method according to claim 42, wherein using the transmitting modem to send a modem identification signal to the receiving modem further comprises using a VDSL Zipper modem to send every 4^{th} tone of the set of N possible tones to a VDSL-TDD modem.

45. (New) The method of claim 42, wherein using the transmitting modem to send a modem identification signal to the receiving modem further comprises using an ADSL modem to send a set of consecutive tones.

46. (New) The method of claim 42, wherein using the transmitting modem to send a modem identification signal to the receiving modem further comprises using an ADSL modem to send every pth tone, where p is a power of 2.

47. (New) A digital subscriber line transmission system using QAM modulation on N=2048 tones or N=4096 tones spaced by 4.3125 kHz, the system comprising:

a transmitting modem; and

means for operating the transmitting modem in a plurality of digital subscriber line standards.

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48. (New) The digital subscriber line transmission system of claim 47, further comprising:

a receiving modem; and

means for operating the receiving modem in the plurality of digital subscriber line standards.

CONT

49. (New) The digital subscriber line transmission system of claim 48, further comprising:

means for enabling the receiving modem to detect an operating mode of the plurality of digital subscriber line standards of the transmitting modem prior to the receiving modem establishing communication with the transmitting modem.

50. (New) The digital subscriber line transmission system of claim 48, further comprising:

means for adjusting an amount of power consumed by the receiving modem and the transmitting modem in dependence on an operating mode of the plurality of digital subscriber line standards of the receiving modem and the transmitting modem.

51. (New) A universal digital subscriber line modem comprising:

an inverse fast Fourier transform circuit having a selectable number of frequency domain inputs and a selectable operating frequency.

52. (New) The universal digital subscriber line modem of claim 51, further comprising:

a fast Fourier transform circuit having a selectable number of frequency domain outputs and a selectable operating frequency; and

B2 a controller configured to control the operating frequency of the inverse fast Fourier transform circuit and the fast Fourier transform circuit.

53. (New) The universal digital subscriber line modem of claim 52, further comprising:

a frequency domain equalizer to receive and operate on an output of the fast Fourier transform circuit.

CONT

54. (New) The universal digital subscriber line modem of claim 53, further comprising:

a radio frequency interference canceller to receive and operate on an output of the frequency domain equalizer.

Claims (clean version)

1. A digital subscriber line transmission system using QAM modulation on N=2048 or 4096 tones spaced by 4.3125 kHz, including at least two operating modes:

a VDSL standard operating mode where all N tones are used to convey significant values; and

an ADSL standard operating mode where only the first n=128 or 256 among the N tones are used to convey significant values.

2 . The system of claim 1, comprising, on the transmitter side:

an inverse fast Fourier transform circuit having N frequency domain value inputs corresponding to said tones, among which only the first receive values corresponding to the n used tones, the remaining inputs being zeroed,

a decimator providing one sample for every r samples output by the inverse fast Fourier transform circuit, with r = N/n, and

a digital-to-analog converter coupled between the decimator and a subscriber line.

3. The system of claim 2, comprising, on the receiver side:

an analog-to-digital converter .sampling the signal on the subscriber line at a frequency F/r, where F is the operating frequency of the inverse fast Fourier transform circuit;

an interpolator generating samples at frequency F from the samples provided by the analog-to-digital converter; and

a fast Fourier transform circuit operating at frequency F and receiving the samples from the interpolator through a time domain equalizer',

wherein, when all N tones are used, the time domain equalizer is bypassed.

4. The system of claim 1 comprising, at a transmitter side, an inverse fast Fourier transform circuit having:

a number of frequency domain inputs selectable at least among values N and n; and

an operating frequency selectable at least among two values F and fn proportional, respectively, to the frequency of the last of the N tones and the last of the n tones.

5. The system of claim 4, comprising, at a receiver side, a fast Fourier transform circuit having:

a number of frequency domain outputs selectable at least among values N and n; and

an operating frequency selectable at least among values F and fn.

6. The system of claim 5, wherein each of the inverse fast Fourier transform and fast Fourier transform circuits includes five radix-4 stages and a last stage having a radix selectable among 2 and 4, all connected to operate in pipeline mode, the desired number of frequency domain inputs or outputs of the circuit being selectable by passing an appropriate number of the five radix-4 stages and by selecting the radix of the last stage.

7. The system of claim 6, wherein the desired number of frequency domain inputs or outputs of the circuit is the product of the radices of all stages which are not bypassed.

8. The system of claim 6

wherein each stage receives and provides complex coefficients at a digital data transmission rate;

wherein each complex coefficient has a real part and an imaginary part;

wherein the real part of each complex coefficient and the imaginary part of each complex coefficient are processed in two distinct cycles; and

wherein the operating frequency of the system is twice the digital data transmission rate.

9. The system of claim 6, wherein an ADSL-Lite standard operating mode is implemented by bypassing two of the five radix-4 stages and selecting the last stage to be radix-2.

10. The system of claim 9, wherein the operating frequency is 1.104 MHz.

11. The system of claim 6, wherein an ADSL standard operating mode is implemented by bypassing two of the five radix-4 stages and selecting the last stage to be radix-4.

12. The system of claim 11, wherein the operating frequency is 2.208 MHz.

13. The system of claim 6, wherein a VDSL standard operating mode, using N= 2048 tones, is implemented by bypassing none of the five radix-4 stages and selecting the last stage to be radix-2.

14. The system of claim 13, wherein the operating frequency is 1 7.664 MHz.

15. The system of claim 6, wherein a VDSL standard operating mode, using N=4096 tones, is implemented by bypassing none of the five radix-4 stages and selecting the last stage to be radix-4.

16. The system of claim 1 5, wherein the operating frequency is 35.328 MHz.

17. The system of claim 6, wherein a VDSL standard operating mode being used for a VDSL-TDD transmission using 512 tones is implemented by bypassing one of the radix-4 stages and selecting the last stage to be radix-2.

18. The system of claim 6, wherein a VDSL standard operating mode being used for a VDSL-TDD transmission using 256 tones is implemented by bypassing two of the radix-4 stages and selecting the last stage to be radix-4.

19. The system of claim 6, wherein a VDSL standard operating mode may be used for a VDSL-TDD transmission, the VDSL-TDD transmission having a maximum frequency of 17.664 MHz.

20. The system of claim 6, wherein a VDSL standard operating mode may be used for a VDSL-TDD transmission, the VDSL-TDD transmission having a maximum frequency of 35.328 MHz.

21. The system of claim 1, wherein a receiving modem can identify the standard operating mode before establishing communication with a transmitting modem.

22. The system of claim 21,

wherein the transmitting modem sends a modem identification signature; and

wherein the receiving modem, by identifying which of the N tones are present in the modem identification signature, identifies the standard operating mode.

23. The system of claim 22, wherein the modem identification signature comprises a signal comprising a plurality of the N tones.

24. The system of claim 23, wherein the modem identification signature of an ADSL modem comprises a plurality of consecutive tones.

25. The system of claim 23,

wherein the transmitting modem is an ADSL modem; and

wherein the modem identification signature comprises every p^{th} tone of the N tones, p being a power of 2.

26. The system of claim 23, wherein the transmitting modem is a VDSL Zipper modem and the receiving modem is a VDSL-TDD modem; and

wherein the modem identification signature comprises every 8^{th} tone of the VDSL Zipper modem.

27. The system of claim 23, wherein the transmitting modem is a VDSL Zipper modem and the receiving modem is a VDSL-TDD modem; and

wherein the modem identification signature comprises every 4^{th} tone of the VDSL Zipper modem.

28. A method for operating a digital subscriber line transmission system, the system using N tones which correspond to N frequency domain value inputs, and having a maximum frequency, the method comprising:

operating the system in a first operating mode, using q tones of the N possible tones as frequency domain value inputs;

zeroing the N-q remaining frequency domain value inputs of the N frequency domain value inputs not included in the q frequency domain value inputs;

setting the operating frequency of the system to q/N of the maximum operating frequency;

operating the system in a second operating mode, the second operating mode using all N frequency domain value inputs; and

setting the operating frequency of the system to the maximum operating frequency.

29. The method of claim 28, wherein operating the system in a first operating mode further comprises selecting the q tones to be used as frequency domain value inputs by bypassing elements of a pipelined circuit.

30. (New) The method of claim 29,

wherein the first operating mode is ADSL standard operating mode;

wherein the pipelined circuit comprises five pipelined radix-4 stages and a last stage operable as radix-2 or radix-4; and

wherein operating the system in the first operating mode further comprises bypassing two of the five pipelined radix-4 stages and operating the last stage as radix-4.

31. The method of claim 30, wherein setting the operating frequency to q/N of the maximum operating frequency further comprises setting the operating frequency of the system to 2.208 MHz.

32. The method of claim 29,

wherein the first operating mode is ADSL-Lite;

wherein the pipelined circuit comprises five pipelined radix-4 stages and a last stage operable as radix-z or radix-4; and

wherein operating the system in the first operating mode further comprises bypassing two of the five pipelined radix-4 stages and operating the last stage as radix-z.

33. The method of claim 32, wherein setting the operating frequency to q/N of the maximum operating frequency further comprises setting the operating frequency of the system to 1.104 MHz.

34. The method of claim 29,

wherein the second operating mode is a VDSL using N=2048 tones;

wherein the pipelined circuit comprises five pipelined radix-4 stages and a last stage operable as radix-z or radix-4; and

wherein operating the system in the second operating mode further comprises not bypassing any of the five pipelined radix-4 stages and operating the last stage as radix-z.

35. The method of claim 34, wherein setting the operating frequency of the system to the maximum operating frequency further comprises setting the operating frequency to 17.664 MHz.

36. The method of claim 29,

wherein the second operating mode is a VDSL standard with N=4096 tones;

wherein the pipelined circuit comprises five pipelined radix-4 stages and a last stage operable as radix-z or radix-4; and

wherein operating the system in the second operating mode further comprises not bypassing any of the five pipelined radix-4 stages and operating the last stage as radix-4.

37. The method of claim 36, wherein setting the operating frequency of the system to the maximum operating frequency further comprises setting the operating frequency to 35.328 MHz.

38. The method of claim 29,

wherein the first operating mode is VDSL-TDD with q=512 frequency domain inputs;

wherein the pipelined circuit comprises five pipelined radix-4 stages and a last stage operable as radix-2 or radix-4; and

wherein operating the system in the first operating mode further comprises bypassing one of the five pipelined radix-4 stages and operating the last stage as radix-2.

39. (New) The method of claim 29,

wherein the first operating mode is a VDSL-TDD standard using q=256 frequency domain inputs;

wherein the pipelined circuit comprises five pipelined radix-4 stages and a last stage operable as radix-2 or radix-4; and

wherein operating the system in the first operating mode further comprises bypassing two of the five pipelined radix-4 stages and operating the last stage as radix-4.

40. A method by which a receiving modem can identify an operating mode of a plurality of operating modes of a transmitting modem using N tones, wherein the transmitting modem and the receiving modem are capable of functioning in any of the a plurality of operating modes, the method comprising:

timing the receiving modem to the transmitting modem prior to the receiving modem establishing a communication with the transmitting modem;

using the transmitting modem to send a modem identification signal to the receiving modem; and

the receiving modem obtaining the modem identification signal and identifying the operating mode.

41. The method according to claim 40, wherein timing the receiving modem to the transmitting modem prior to the receiving modem establishing communication with the transmitting modem further comprises the receiving modem using at least the N tones used by the transmitting modem.

42. The method according to claim 41, wherein using the transmitting modem to send a modem identification signal to the receiving modem further comprises the transmitting modem sending a specific set of tones chosen from the set of N possible tones.

43. The method according to claim 42, wherein using the transmitting modem to send a modem identification signal to the receiving modem further comprises using a VDSL Zipper modem to send every 8^{th} tone of the set of N possible tones to a VDSL-TDD modem.

44. The method according to claim 42, wherein using the transmitting modem to send a modem identification signal to the receiving modem further comprises using a VDSL Zipper modem to send every 4^{th} tone of the set of N possible tones to a VDSL-TDD modem.

45. The method of claim 42, wherein using the transmitting modem to send a modem identification signal to the receiving modem further comprises using an ADSL modem to send a set of consecutive tones.

46. The method of claim 42, wherein using the transmitting modem to send a modem identification signal to the receiving modem further comprises using an ADSL modem to send every pth tone, where p is a power of 2.

47. A digital subscriber line transmission system using QAM modulation on N=2048 tones or N=4096 tones spaced by 4.3125 kHz, the system comprising:

a transmitting modem; and

means for operating the transmitting modem in a plurality of digital subscriber line standards.

48. The digital subscriber line transmission system of claim 47, further comprising:

a receiving modem; and

means for operating the receiving modem in the plurality of digital subscriber line standards.

49. The digital subscriber line transmission system of claim 48, further comprising:

means for enabling the receiving modem to detect an operating mode of the plurality of digital subscriber line standards of the transmitting modem prior to the receiving modem establishing communication with the transmitting modem.

50. The digital subscriber line transmission system of claim 48, further comprising:

means for adjusting an amount of power consumed by the receiving modem and the transmitting modem in dependence on an operating mode of the plurality of digital subscriber line standards of the receiving modem and the transmitting modem.

51. A universal digital subscriber line modem comprising:

an inverse fast Fourier transform circuit having a selectable number of frequency domain inputs and a selectable operating frequency.

52. The universal digital subscriber line modem of claim 51, further comprising:

a fast Fourier transform circuit having a selectable number of frequency domain outputs and a selectable operating frequency; and

a controller configured to control the operating frequency of the inverse fast Fourier transform circuit and the fast Fourier transform circuit.

53. The universal digital subscriber line modem of claim 52, further comprising:

a frequency domain equalizer to receive and operate on an output of the fast Fourier transform circuit.

54. The universal digital subscriber line modem of claim 53, further comprising:

a radio frequency interference canceller to receive and operate on an output of the frequency domain equalizer.